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AUTHOR Harrell, Thomas H.
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ABSTRACT

This discussion of the design of computerized psychological assessment or testing instruments stresses the importance of the well-designed computer-user interface. The principles underlying the three main functional elements of computer-user dialogue--data entry, data display, and sequential control--are discussed, and basic guidelines derived from these principles are provided. Finally, the future direction of interface design is considered. Nine references are listed. (EW)

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DESIGNING USER - COMPUTER DIALOGUES: BASIC PRINCIPLES AND GUIDELINES[1]

Thomas H. Harrell, Ph.D.
School of Psychology Florida Institute of Technology

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DESIGNING USER - COMPUTER DIALOGUES: BASIC PRINCIPLES AND GUIDELINES

In the development of computer-based assessment systems in psychology, special attention must be given to the design of the user - computer interface. Users differ in their ability and exposure to computer applications. In most assessment settings, users are clients or patients, who are concerned with their task performance and how they are being evaluated while using the computer, but have limited knowledge of the computer tool. Design of the user - computer interface must take these factors into account.

The computer's emerging role in psychological assessment applications has been based primarily on the development of software programs designed to administer traditional psychological tests. These programs operate on commercially available hardware systems. Thus the current emphasis in interface design is on development of software which controls the user - computer dialogue rather than design of the hardware and physical issues such as keyboard layout and display contrast. In fact, among current software development issues, the user - computer interface is increasingly viewed as the major determinant of the success or failure of a given computer system (Gaines & Shaw, 1986).

In contemporary psychological assessment, the issue of test equivalence has become prominent in the process of automating traditional psychological testing instruments. As pointed out by Harrell, et al. (1987) and Honaker (1987, this symposium), computerization changes one of the most basic technical elements of test standardization; the mode of test administration. This is most likely to effect the *experiential* equivalence of the two test forms; as the nature of item display, the mode of responding, and user flexibility in responding are inherently modified when computer interaction is required. These changes may consequently alter affective, perceptual, and attitudinal reactions to the test. As indicated by Honaker (1987, this symposium), there has been considerable variation in the user-computer interface of assessment software utilized in equivalency research. In many cases, author-developed software has been utilized; while in some studies, commercially available programs have been used. Thus, previous research may have inadvertently investigated a *range of alternative forms* of computer administration.

It is widely accepted that there are a number of design criteria to be fulfilled in order to produce "good" user - computer dialogues (see Smith and Mosier, 1984 for a good example of criteria and guidelines for complex interface systems). Standards and guidelines for the design of general user-computer interfaces are applicable to the item presentation and response option issues particular to psychological test administration. In this presentation I will outline the basic principles of user - computer dialogue development in the area of psychological test automation. I will also emphasize principles related to maintaining equivalence between traditional and computer test administration.

The principle functional elements of user - computer dialogues include data display, data entry,

and sequence control. Data display encompasses presentation of instructions and test items to the user via the computer's display screen. Data entry is concerned with input by the user of data items to be processed by the computer. Sequence control involves the logic and means by which inputs and outputs are linked to become coherent transactions, and which govern the transitions from one transaction to the next. Within each of these elements there are specific principles and guidelines for design. When these are taken into consideration, the overall logic of the user - computer dialogue is increased, allowing the user to concentrate on the application, rather than the computer medium.

DATA DISPLAY

When the computer is utilized for test administration, the user's interaction with the computer begins with the screen display. The user looks to the display to provide information about how to take the test. The content of test instructions displayed via computer should, of course, be the same as those provided for in the traditional mode.

However, in addition to those instructions, the user will need instructions regarding use of the computer in place of the more familiar paper and pencil. It is necessary to provide an introduction to the computer keyboard, and to the specific process of using the keyboard to enter information, change responses, and review previous responses. A good introduction will display the keyboard on the screen, graphically identify relevant keys, and provide example items which allow the user to practice use of the keyboard and receive specific feedback regarding their responses.

Three principles underlie development of display screens for psychological testing:

1. Display formatting should be guided by its' principle function: to display data which the user can easily assimilate and from which the user can quickly extract information. It is important to remember that computers provide and display data, it is the user who extracts information from that data.
2. Display formatting should parallel traditional data presentation, if equivalence is of concern. Within that constraint, display formatting guidelines may not indicate what the specific contents of a display should be, but only how those contents should be presented.
3. Data presentation should be consistent: the user should always know where to look for the same or similar data on different screens.

Some basic guidelines which follow from these principles:

1. A common standard is to display only one test item and it's associated response options per screen
2. If equivalence with traditional formats is desired, use a format similar to the paper-and-pencil one for greater equivalence
3. Use consistent terminology : for displayed data and labels, choose words carefully and then use them consistently.

ex. the word "screen" should not be used in one place where "display" or "monitor" is used in another

4. Observe conventional use of mixed case (upper/lower)

   exception: a label or title intended to attract a user's attention might be displayed in upper case, or reverse video, or highlighted.

   Normally, text is easier to read with conventional use of mixed case.

5. Use affirmative wording when possible:

   ex. Answer all items before leaving this section (good)

   Do not leave this section before answering all items (bad)

   always tell the user what to do, rather than what to avoid.

6. Use Active voice rather than passive voice; it is easier to understand

   ex. Clear the screen by pressing CONTINUE (Active)

   The screen is cleared by pressing CONTINUE (Passive)

7. Place title displays at top, be concise yet descriptive

   Reserve bottom lines of display for status and error messages, prompts to the user

8. Keep screens simple. Think in terms of what an individual focuses on when using a traditional mode of administration.

DATA ENTRY

The principle task for the user when completing a psychological test on the computer is to enter the specified data, primarily answers to questions. As noted earlier, the computer is only the medium for test administration, and therefore should intrude on the user only when necessary to prompt the user to respond, to provide expected feedback, and to alert the user to errors in entries.

A fundamental decision in interface design is the selection of the dialogue types that will be used to implement data entry. However, for traditional psychological testing applications, dialogue types may be constrained by the need for consistency with the standard administration mode. In most current psychological testing applications, the greatest percentage of screens display questions and response options. Multiple choice and T/F formats prevail, although fill-in-the-blank and sentence completion are not uncommon response requirements. Form filling, such as typing in one's name, social security number, completing sentences, or typing in short paragraphs provides greater flexibility in data entry, but requires more user training and more extensive computer prompting.

The primary objectives in developing data entry dialogues for psychological testing are:

1. Minimizing the necessary input actions and memory load on the user
2. Maintaining consistency of data entry transactions thoughout the dialogue
3. Allowing flexibility in user control by enabling review of entries and error correction
4. Using an overall logic which enables the user to feel <u>in control</u> of the data entry

process, not manipulated by the computer

Guidelines for data entry design:

1. Provide displayed feedback for all user actions during data entry.
   ex. key presses should be followed by a display of the associated symbol or an explicit acknowledgement of the key press via a more extensive response displayed by the computer
2. Allow a consistent input method: the user should be able to stay with one method of data entry or to use consistent methods for same types of data.
   ex. keyboard for textual input, keypad for numerical inputs
3. Incorporate defined display areas for data entry: clear visual definition of data entry areas or fields provides explicit guidance as to the location and extent of data entry.
   ex. underlined or reverse-video highlighted fields, which are replaced by data entries; ENTER moves cursor to next data field
   Highlight selected data or options: when user is performing an operation on a particular display item or has selected a particular option, it should be highlighted.
4. Provide a clear and consistent method for data review and change of entries.
   ex. use of BACK-UP key and ERASE (delete) functions which parallel familiar test-taking functions
   all changes should be immediately displayed to the user
5. Require an explicit ENTER action to move to another stage of data entry or to initiate processing of data
   processing should never be a side effect of some other action
6. Provide a clearly labeled ENTER key and use consistently
7. Provide confirmations of completed user actions: the computer should acknowledge completion of a data entry sequence with a confirmation message or an explicit error message
   ex. Continue to next item; The test is now completed
8. Avoid use of abbreviations, esp. with novice users
   (reduces memory load)
9. The computer should provide explicit prompts for data entry, such as required format, acceptable values, or valid options
10. Include all relevant options to users
    in some cases an open option may be needed: i.e., Other: _____
11. Use single keystroke character entry
    avoid complex keying methods such as having to press more than one key simultaneously
    ex. avoid use of CTRL or OPTION key sequences
12. Observe upper/lower case equivalence: for data entry other than text, treat upper and lower case letters as equivalent
13. For text entry, display all entered textual material, as entered, with full editing capabilities and cursor movement.

14. Automatic word-wrap at right margin
15. Provide automatic data validation - the computer should check entries for incorrect content wherever specific ranges or limits exist.
    ex. dates / ages / sex / T/F and multiple choice questions
18. Clear error messages should be provided during data input - error messages should indicate appropriate entries
    ex. Acceptable responses must range from 1 to 5
    ex. Press T for true
        Press F for false
        Press Back-up to review the previous question

SEQUENCE CONTROL

Sequence control refers specifically to the computer logic and user actions which initiate, interrupt, and terminate the user - computer dialogue. These elements govern the transitions from one transaction to the next, and evaluate the appropriateness of user inputs.

A critical determinant of user satisfaction and acceptance of a computer system is the degree to which the user feels in control. If the user cannot control the direction and pace of the dialogue, then he/she is likely to feel frustration and/or intimidation. (Brown et al., 1983). Thus, the software logic should anticipate every possible action by user, no matter how improbable, and provide an appropriate computer response to random inputs as well as correct entries and likely errors. In particular, a dialogue should never reach a dead end with no further action available to the user. If an inappropriate entry is made, the computer should display an advisory message indicating the available response options and their meaning.

Principles of sequence control in automated psychological testing applications:

1. The computer program must perform in an efficient, reliable, and predictable manner; surprises and dead-ends are frustrating to users
2. The software should require minimal program control actions by the user. Design the program to be self-explanatory in operation and do not require the user to perform any unusual "computer operations" in order to initiate or terminate the program.
3. The internal operations of the computer should be transparent to the user, except in those cases where informing the user of computer operation allows the user a greater sense of control.
4. Users will make errors, and dialogue design must facilitate detection and correction of those errors.

Guidelines:

1. The user should not be faced with sequence control activities related to operation of the program A common example is Menu Selections, which have no analogue in traditional assessment formats

2. Function keys should be used sparingly, and should be designed to duplicate traditional test-taking activities such as erasing, returning to an earlier item, and continuing to the next item

   While these functions are necessary to simulate traditional test-taking actions, they require some training and computer prompting.

   Function keys should be labeled distinctively on keyboard, should operate with single keying, and should be placed in a distinctive and convenient location on the keyboard.
3. Keep control and function keys consistent across in form and consequence thoroughout the dialogue

   the terminology used in diplay/keyboard labels of functions should be consistent as well
4. Features relevant to sequence and control should be displayed in a distinctive position and/or format, either bold/highlighted/reverse videoed/ at bottom of screen
5. Every control action by the user should result in an acknowledgement by the computer, either by one of the following:

   a) execution of a request

   b) a message indicating the transaction is completed or in progress

   c) a message that the control action is in error and the available options

   The absence of a computer response is not an acceptable means of indicating that a control entry is being processed.
6. If a selection is made which is invalid for a particular transaction, no action should result except display of an advisory message indicating what selections are appropriate at that point

   - messages should indicate what is wrong and what can be done about it.

   - the cursor should be repositioned to the faulty entry
7. Permit user to return easily to previous steps in a transaction sequence in order to correct an error or make a change - need flexible back-up command
8. Inform the user when all data is entered, and provide appropriate guidance for further user actions

   "The test is now completed and the computer is saving your answers to the questions. Thank you for your cooperation. Please let the examiner know that you have finished."

FUTURE DIRECTIONS

The purpose of investigating and evaluating user - computer dialogues is to enhance the "usability" of the computer (Gould & Lewis, 1985). While there is no comprehensive or generally accepted model of how to design usability into computer systems, all approaches seek to bring the user - computer interface in line with the user's common knowledge and experience base. In the area of automated psychological assessment, our contemporary emphasis is on providing a usable interface, while maintaining consistency with the original assessment formats. However, our real challenge in the future is in developing new assessment procedures which take advantage of the strengths and capabilities of the computer medium, especially where we can

combine those capabilities with metaphors familiar to everyday experience.

The nature of user - computer dialogues was tremendously expanded by the development of the representational interface, as exemplified in the MacIntosh computer. The representational interface utilizes pictographic symbols, or icons, to represent underlying functions of the computer. Icon design capitalizes on their information-carrying capacity by unifying individual icons into a collective metaphor. Thus the icons in the interface have a form which corresponds to actual objects in the real world, with which users are familiar. The metaphor uses the established attributes and associations of the real-world objects, carrying them over into the model of the interface presented to the user (Gittins, 1986). For example, the computer screen may be conceptualized as a desktop, with icons provided to represent the documents, files, mail trays, and rubbish bins found in the typical office. In this office metaphor interface, users can metaphorically "see" their actions and the consequences of those actions, using familiar cognitive representations.

This enhancement of usability capitalizes on the recognition that people tend to try to learn about new things by making use of their previous learning experiences. New concepts are often thought of in terms of old, familiar concepts - at least initially, and new cognitive structures are often developed by metaphorically expanding old ones (see Ortony, 1979; Snow et al., 1980). In the previous example, the naive user may approach the task of understanding the computer by drawing upon what he/she already knows about an office. But there is no reason why we cannot develop interface metaphors based upon interpersonal situations and dilemmas, and evaluate the user's ability to utilize those metaphors.

Thus, the computer medium provides us with the opportunity to simulate the development and use of metaphors in the learning process, and to interact with representations of our cognitive structures. Psychological theory and methods are providing a foundation for better interface design; but reciprocally, interface design provides a rich and practical domain in which we can evaluate complex human learning and behavior.

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NOTE

[1] The design principles and guidelines presented in this paper are not novel, nor are they in any way the exclusive product of the author. They simply represent the author's distillation of numerous and more comprehensive reports and recommendations found in the literature on interface design, coupled with an emphasis directed toward their utility and importance in automated psychological assessment applications.